TITLE OF THE INVENTION

DIGITAL BROADCASTING APPARATUS AND METHOD, VIDEO DATA ENCODING SYSTEM AND METHOD, AND BROADCASTING SIGNAL DECODING SYSTEM AND METHOD, WHICH USE VARIABLE BIT RATE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. Patent Application No. 09/985,021, filed November 1, 2001 and which is pending, and claims the benefit of Korean Application No. 2001-22425, filed April 25, 2001, in the Korean Industrial Property Office, the disclosures of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to an apparatus to transmit a digital broadcasting signal, and more particularly, to an apparatus and a method to transmit a digital broadcasting signal, an apparatus and a method to encode video data, and a system and a method to decode the broadcasting signal that is capable of transmitting more data about additional information using a variable bit rate for a video signal having a constant bit rate by varying a bit rate of the video signal in accordance with a complexity of a video signal for a transmission.

Description of the Related Art

[0003] Recently, digital broadcasting services have undergone a remarkable market expansion throughout the U.S.A., European countries, and Japan by utilizing satellites or ground waves. The digital broadcasting services provide a complex array of multimedia services such as video broadcasting, audio broadcasting, and data broadcasting that includes additional information data broadcasting.

[0004] The data broadcasting service of the digital broadcasting services provides multimedia contents, such as text information, still video, product information, Electronic Program Guide (EPG), etc., that are the main part of the multimedia service of the digital broadcasting services.

[0005] The data broadcasting services are also useful for the broadcasting companies that could provide various types of information through the data broadcasting such as breaking news type news updates, sports events, real-time reports on stock transactions, weather reports, traffic information, home shopping, and TV program guides, or the like. Also,

by providing push-type information updates to receivers, the broadcasting companies can allow the viewers to search their desired information more simply.

[0006] Currently, the digital broadcasting services provide data of 20-23 Mbps via one channel of a predetermined MHz (6MHz in case of current U.S. ground wave broadcasting). For broadcasting purposes, the data signals of compressed video, audio, and additional information data have fixed bit rates, respectively. That is, the bit rates of the video, audio, and data broadcastings are predetermined for one channel, and the respective data services are provided at such predetermined bit rates.

[0007] FIG. 1A shows a conventional broadcasting signal having a fixed bit rate. Referring to FIG. 1A, the video data, audio data, and additional information data are transmitted at a constant bit rate (CBR) that has a fixed bit rate threshold. For example, when the 20 Mbps data is transmitted via one channel, the video data takes up the vast proportion of the bit rate by taking approximately 18 Mbps of the 20 Mbps data, followed by audio data and additional information data, which are transmitted at relatively lower bit rates.

[0008] Meanwhile, there can be video signals for broadcasting live activities such as sports events, or less live activities such as news programs. For the live activities, the vast amount of video data has to be compressed adequately to not exceed the fixed bit rate threshold. The video data of less live activities, such as a news program (i.e., the data of less amount) has to be compressed relatively less in order to meet the fixed bit rate threshold. And when the fixed bit rate threshold is not satisfied after the compression, dummy bits are added to meet the fixed bit rate threshold.

[0009] FIG. 1B shows one example of video data transmitted at a constant bit rate, and FIG. 1C shows one example of the broadcasting signal including audio data and additional information data to which the video data of FIG. 1B is adapted. In FIG. 1B, a cross-hatched region is the area for more compression, while a dotted region is the area for dummy bit insertion.

[0010] Accordingly, when transmitting the video data at the constant bit rate, the image quality depends on the characteristics of the videos. For example, since the data of a simple video is transmitted with the image quality higher than necessary in order to meet the constant bit rate, the channel utilization deteriorates.

[0011] As described above, the broadcasting process using the constant bit rates have considerable problems, especially in terms of channel utilization.

SUMMARY OF THE INVENTION

[0012] In order to overcome the above and other problems of the related art, it is an object of the present invention to provide a digital broadcasting apparatus to transmit video data, audio data and additional information data at a fixed bit rate, which makes use of a variable bit rate by using a bit rate saved from an area of less video data for a transmission of data broadcasting.

[0013] Another object of the present invention is to provide a video data encoding apparatus and a method thereof that make use of a variable bit rate by inserting data about additional information in a user data region saved from a less video area of limited video signal bit rates.

[0014] Yet another object of the present invention is to provide a broadcasting signal decoding system and a method thereof to decode a broadcasting signal encoded by the above encoding apparatus and the method that make use of variable bit rates.

[0015] Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0016] The above and other objects are accomplished by a digital broadcasting signal transmission apparatus that receives a digital broadcasting signal containing a video signal, an audio signal and data of additional information, encodes the digital broadcasting signal, converts the encoded signal into a predetermined transmission type, and transmits the converted signal, the digital broadcasting signal transmitting apparatus that uses a variable bit rate includes a video analyzing portion that determines a bit rate allocated to the video signal and to the data of the additional information in accordance with the input video signal, and then outputs the determined bit rates, a video encoder that encodes the input video signal in accordance with the bit rate allocated to the video signal, and a data formatting portion that receives the data of the additional information to the extent the bit rate allocated to the additional information allows, and then converts the received data of the additional information into a predetermined data broadcasting format.

[0017] According to an aspect of the present invention, the video analyzing portion includes a screen analyzing portion that analyzes a complexity of the input video signal, and outputs the analyzed complexity of the input video signal, a motion analyzing portion that calculates a difference between respective screens from the input video signal, and calculates a degree of motion of the screen based on the calculated difference, and outputs

the calculated result about the degree of the motion, and a bit rate determining portion that receives the information about the video characteristics from the video encoder, and also receives the information about the complexity and degree of motion of the screen, and then determines the bit rates for the video signal and for the additional information.

[0018] According to another embodiment of the present invention, a broadcasting signal encoding apparatus that receives and encodes broadcasting data and uses a variable bit rate includes a broadcasting data analyzing portion that analyzes a complexity of the input broadcasting data, and determines an amount of user data that is insertable, a user data insertion portion that receives the data of the additional information for service and then inserts the data of the additional information as the user data in accordance with the determined amount of the user data that is insertable, and a transmitting portion that transmits the encoded broadcasting data and the inserted user data.

[0019] According to yet another embodiment of the present invention, a broadcasting signal decoding apparatus that receives and decodes broadcasting data containing encoded video data, encoded audio data, and encoded data of the additional information and uses a variable bit rate includes a user data outputting portion that outputs user data from the broadcasting data, and a data decoding portion that receives the output user data and decodes the received output user data to decode the data of the additional information.

[0020] According to still another embodiment of the present invention, a broadcasting signal decoding apparatus that receives broadcasting data containing encoded video data, encoded audio data, and encoded data of the additional information and uses a variable bit rate includes a user data outputting portion that outputs user data from the broadcasting data, an additional information data decoding portion that receives and decodes the data of the additional information, and a user data decoding portion that receives and decodes the output user data.

[0021] According to a further embodiment of the present invention, a digital broadcasting signal transmitting method of receiving a digital broadcasting signal containing a video signal, an audio signal and data of the additional information, encoding the digital broadcasting signal, converting the encoded signal into a predetermined transmission type, transmitting the converted signal and using a variable bit rate, includes determining a bit rate allocated to the video signal and a bit rate allocated to the additional information in accordance with the input video signal, and outputting the result, encoding the input video signal in accordance with the bit rate allocated to the video signal, and receiving the data of the additional information to the extent the bit rate allocated to the additional information allows, and

converting the received data of the additional information into a predetermined data broadcasting format.

[0022] According to a yet further embodiment of the present invention, a method performed by a digital broadcasting signal transmitting apparatus for receiving and encoding broadcasting data, and using a variable bit rate includes analyzing a complexity of the received broadcasting data, and determining an amount of user data insertion, receiving the data of the additional information for service and then inserting user data in accordance with the determined amount of user data insertion, and transmitting the encoded broadcasting data and the inserted user data.

[0023] According to a still further embodiment of the present invention, a method of receiving and decoding broadcasting data containing encoded video data, encoded audio data, and encoded data of the additional information, and using a variable bit rate includes outputting the data of the additional information from the broadcasting data, and receiving and decoding the output data of the additional information.

[0024] According to a yet still further embodiment of the present invention, a method of receiving and decoding broadcasting data containing encoded video data, encoded audio data, and encoded data of the additional information, and using a variable bit rate includes outputting user data from the broadcasting data, and receiving the output user data and decoding the received user data to decode the data of the additional information.

[0025] According to an additional embodiment of the present invention, a method of receiving and decoding broadcasting data containing encoded video data, encoded audio data, and encoded data of the additional information, and using a variable bit rate includes outputting user data from the broadcasting data, and receiving and decoding the data of the additional information, and receiving and decoding the output user data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] These and other objects and advantages of the invention, and many of the attendant advantages thereof, will be more readily apparent and appreciated as the same becomes better understood by reference to the following detailed description of preferred embodiments thereof when considered in conjunction with the accompanying drawings in which like reference symbols indicate the same or similar components, wherein:

FIG. 1A is a view showing a conventional general broadcasting signal having a constant bit rate;

FIG. 1B is a view showing a conventional example of video data being transmitted at the constant bit rate;

FIG. 1C is a view showing a conventional example of the broadcasting signal using the video data of FIG. 1B;

FIG. 2 is a block diagram showing a digital broadcasting transmitting apparatus in accordance with an embodiment of the present invention;

FIG. 3 is a block diagram of a video analyzing portion of FIG. 2;

FIG. 4 is a block diagram showing a digital broadcasting receiving apparatus in accordance with an embodiment of the present invention;

FIG. 5 is a block diagram showing a video data encoding apparatus in accordance with another embodiment of the present invention;

FIG. 6 is a view showing an example of the broadcasting signal being transmitted from the broadcasting signal encoding apparatus in accordance with a further embodiment of the present invention;

FIG. 7 is a block diagram showing a broadcasting signal decoding apparatus in accordance with an embodiment of the present invention;

FIG. 8 is a block diagram showing a broadcasting signal decoding apparatus in accordance with the another embodiment of the present invention; and

FIG. 9 is a block diagram showing the broadcasting signal decoding apparatus in accordance with a further embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0027] Reference will now be made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures. Any redundant explanation is omitted to the extent possible.

[0028] A digital broadcasting transmitting apparatus according to an embodiment of the present invention makes use of a variable bit rate to provide various multimedia services by saving the bit rates that would otherwise be wasted for the videos having less data. In FIG. 2, which is a block diagram of the digital broadcasting transmitting apparatus in accordance with the embodiment of the present invention, the digital broadcasting transmitting apparatus includes a video analyzing portion 11, a video encoder 12, an audio encoder 13, a data formatting portion 14, a first packet converting portion 15, a second packet converting portion 16, a third packet converting portion 17, and a TS multiplexer 18.

[0029] The video analyzing portion 11 receives video signals and video characteristic data generated by the video encoder 12, and determines a bit rate to be allocated to the video signal and a bit rate to be allocated to the transmission of the additional information. The operation of the video analyzing portion 11 will be described later in detail.

[0030] The video encoder 12 and the audio encoder 13 receive the video data and audio data respectively, and compress the received video and audio data at a predetermined bit rate into corresponding bit streams. The video encoder 12 generates the video characteristic data of the input video signal. The video encoder 12 receives the video bit rate for the video signal, which is variable by time, from the video analyzing portion 11, and encodes the video signal in accordance with the input video bit rate.

[0031] Here, the video characteristic data generated by the video encoder 12 includes various data that indicate the characteristics of the video signal. These characteristics include, but are not limited to, a quantizing level of the video signal, motion vectors, and an average image quality.

[0032] In accordance with the additional information bit rate for the additional information data received from the video analyzing portion 11, the data formatting portion 14 converts the format of the additional information data into a data broadcasting format that is predetermined by a digital broadcasting system. The first through third packet converting portions 15 through 17 receive the corresponding encoded video bit stream, the encoded audio bit stream, and the additional information data bit stream from the video encoder 12, the audio encoder 13, and the data formatting portion 14. The packet converting portions 15 through 17 convert the respective bit streams into packets of a predetermined length.

[0033] It is preferable, but not required, that the respective bit streams further include predetermined header information. The predetermined header information indicates that the encoded video bit stream or the additional information data bit stream is encoded at a variable bit rate, which helps to more efficiently decode the bit stream at the receiving apparatus that receives the video bit stream or the additional information data bit stream.

[0034] The packets generated from the first through third packet converting portions 15 through 17 are multiplexed by the TS multiplexer 18 so as to generate a Transport Stream (TS). The TS is modulated by a predetermined transmission method (e.g., 8-Vestigial Side Band of U.S. ground wave broadcasting), and transmitted.

[0035] FIG. 3 is a block diagram of the video analyzing portion 11 of FIG. 2. The video analyzing portion 11 includes a screen analyzing portion 111, a motion analyzing portion 112,

and a bit rate determining portion 113. The screen analyzing portion 111 analyzes the complexity of the input video signal, and outputs the analyzed result. The motion analyzing portion 112 calculates a difference between each screen based on the input video signals, and also calculates the degree of motion in the screen based on the calculated difference. Then the motion analyzing portion 112 outputs motion data about the motion.

[0036] The bit rate determining portion 113 uses the video characteristic data input from the video encoder 12, the screen complexity input from the screen analyzing portion 111, and the motion data input from the motion analyzing portion 112, and outputs the video bit rate and the additional information data bit rate. Preferably, the bit rate determining portion 113 determines a higher video bit rate as the complexity and motion of the screen become greater, and conversely determines a lower additional information data bit rate as the complexity and the motion of the screen increases. However, this is not required in all circumstances.

[0037] The bit rate determining portion 113 also may use only the video characteristic data input from the video encoder 12 to determine the video bit rate and the additional information data bit rate. In the above case, it is preferable that, as the average quantizing level of the video characteristic data becomes greater, or as the average motion vector becomes greater, the higher the determined video bit rate is. Conversely, the higher the video bit rate, the lower additional information data bit rate is determined. However, this is not required in all circumstances.

[0038] FIG. 4 is a block diagram of the digital broadcasting receiving apparatus in accordance with an embodiment of the present invention. The TS packet, input from a predetermined input end, is input to a demultiplexer 21, and divided and output in a video packet, audio packet, and additional information data packet, respectively. The video and the audio packets are input to first and the second packet processing portions 22 and 23, are converted into corresponding video and audio bit streams, and output. The video bit stream and the audio bit stream are input to a corresponding video decoder 25 and an audio decoder 26, and decoded into the video data and the audio data of the previous form before the compression, and output.

[0039] The additional information data packet is input to a corresponding packet dividing portion, and thus divided into a signal for controlling (i.e., synchronizing) the operation of the video and the audio decoders 25 and 26. An additional information data processing portion 24 processes the input additional information data in accordance with the data transmission method of the digital broadcasting system, and outputs the processed result. The data

transmission method of the digital broadcasting system varies depending on the data broadcasting type provided by the respective broadcasting companies. Also, the output of the processed result also varies according to the type of the data broadcasting. For example, if the additional information is about the data broadcasting such as a stock transaction, the additional information usually includes codes of the respective companies, current prices, status of stock transaction, etc., which are tabled to be output.

[0040] Meanwhile, the data for data broadcasting output from the additional information processing portion 24 can be indicated by the combination of the decoded video signals or audio signals.

[0041] The video data encoding and decoding apparatuses in accordance with another embodiment of the present invention makes use of the variable bit rate by inserting the data of the additional information in a user data region, where the user data region is secured in an area of less video among the bit rates of limited video signals. FIG. 5 is a block diagram of the video data encoding apparatus in accordance with another embodiment of the present invention. The video data encoding apparatus includes an NxN converting portion 31 to convert video data of a predetermined block unit applied through an input end (a) into data within a frequency range, a quantizing portion 32 to quantize the converted conversion factor, a variable field encoding portion 33 to variable-field encode the quantized data, an inverse quantizing portion 35 to inverse-quantize the quantized data, an inverse NxN converting portion 36 to inverse convert the inverse-quantized signal, a frame memory 37, a motion estimating portion 38 and a motion compensating portion 39 to motion-estimate and compensate for the screens reconstructed by the inverse conversion and also for the blocks to be encoded, a video analyzing portion 41 to analyze and determine an amount of data to be inserted. In addition, a user data inserting portion 42 receives the data for service from an input (b) and transmits the received data in accordance with the amount of the data for user insertion. A buffer 34 receives and stores both the inconsistently input compressed video data and user data, and transmits the input compressed video and user data at a constant speed. Further, a quantization level to prevent overflow or underflow is transmitted from the quantizing portion 32 and a motion vector is transmitted from the dynamic estimating portion 38.

[0042] In the current broadcasting services, the video data, the audio data, and the additional information data have constant bit rates for the respective broadcastings as shown in FIG. 1A. Further, the video data has a construction in which a header is combined with the user data and the actual transmission data. A user data region is defined to be used by the broadcasting companies or by the transmitters of the broadcasting services. As described

above, there occasionally is a case that the screen having less motion (i.e., the screen of less video data) is compressed accordingly less in order to meet the predetermined bit rate threshold. The problem with this is that, even according to the above conventional method, it is possible that the predetermined bit rate threshold is not met.

[0043] Accordingly, the video analyzing portion 41 analyzes the complexity of the input video data and determines how large the area is (cross hatching in FIG. 1B) that indicates the shortage of the video signal transmitted at the fixed bit rate from the predetermined bit rate threshold. Here, the region designated by the cross hatching indicates the area where the dummy bit data are conventionally added. The video analyzing portion 41 thus determines the amount of data about the additional information that is to be inserted in the cross hatching area of FIG. 1B instead of the dummy bit data.

[0044] The video analyzing portion 41 may directly receive the video data and calculate the complexity of the screen. Alternatively, the video analyzing portion 41 may receive the video characteristic information output from the video encoder 12 and determine the user data amount to be used for the transmission of the additional information data. Meanwhile, the complexity of the video data and the video characteristic information may also be used in combination. As described above, the video characteristic information includes information that indicates the characteristics of the video, such as a quantizing level of the currently encoded video, a motion vector, a quality of decoded video, etc.

[0045] Next, the user data inserting portion 42 receives the data for service through the input end (b), and transmits the received data by an amount that corresponds to the amount of the user data that can be inserted as determined by the screen complexity analyzing portion 41. The inserted additional information data is therefore transmitted in the user data region of the video data.

[0046] FIG. 6 is a view showing one example of the broadcasting signal transmitted in the broadcasting signal encoding apparatus in accordance with an embodiment of the present invention. As shown in FIG. 6, while the video data, the audio data, and the additional information data are maintained at a predetermined constant bit rate, within the bit rate allocated to the video data, the additional information data is added in the area of less video signals to maintain the video bit rate threshold indicated by the dashed line.

[0047] Examples of the additional information data currently available includes a transport packet type of 188 byte unit, a proprietary file format/service format type, a java byte code type, audio data, image data, video data, data broadcasting data, and a data service format provided by the broadcasting operator. The additional information data inserted in the user

data region accordingly is one of the above types, but it is understood that other types of additional data exist and will be developed.

[0048] The decoding apparatus of the broadcasting apparatus in accordance with a further embodiment of the present invention will be described below with reference to FIG. 7. A transport stream input to the decoding apparatus of FIG. 7 includes video data allocated at a fixed bit rate, audio data, additional information data, and additional information data inserted at a variable bit rate in the video data region that is allocated at the fixed bit rate. The transport stream is divided into video data, audio data (not shown), and additional information data by a first dividing portion 61. The divided video data is input to a second dividing portion 62, from which the video data is re-divided and output as video coded data (VCD), motion vector (MV), and user data. The VCD is input to the video data decoding portion 50 to be decoded. The additional information data divided by the first dividing portion 61, and the user data output from the second dividing portion 62 are input to the data decoder 63 to be decoded to restore the complete data service.

[0049] The above-mentioned decoding apparatus is used in the case that the additional information data divided by the first dividing portion 61 and the user data from the second dividing portion 62 are in the same format. It is understood, but not shown, that a translator to translate the user data and/or the additional information data into a common format to be decoded by the data decoder 63.

[0050] FIG. 8 is a block diagram of a further embodiment of the broadcasting signal decoding apparatus in accordance with the present invention. The additional information data divided by the first dividing portion 61 of the broadcasting signal decoding apparatus is input to the first decoder 72 to be decoded for a first data service. Further, the user data output from the second dividing portion 62 is input to the second decoder 71 to be decoded for a second data service. The first and second data services can be combined, but need not be combined in all instances. Accordingly, a broadcasting signal decoding apparatus may be used in the case that the additional information data divided by the first dividing portion 61 and the user data output from the second dividing portion 62 are in the respectively different formats.

[0051] FIG. 9 is a block diagram for showing a yet further embodiment of the broadcasting signal decoding apparatus in accordance with the present invention. The additional information data divided by the first dividing portion 61 is input to the first decoder 72 to be decoded. The user data output from the second dividing portion 62 is input to the second decoder 72 to be decoded. The data decoded by the first decoder 72 and the data decoded

by the second decoder 71 are added by an adder A3 to be output as a combined data service, such as a database.

[0052] Accordingly, the broadcasting signal decoding apparatus shown in FIG. 9 is used when the additional information data divided by the first dividing portion 61 and the user data output from the second dividing portion 62 are in the respectively different formats, but are also in the same display format with each other.

[0053] Although the above-described preferred embodiments are directed to the video data as an example, transmission of the additional information according to the present invention is also applicable to the audio data, or to combinations of the video and the audio data. Further, it is understood that the transmission can also occur by encoding the audio and/or video data, and the additional information data according the present invention on a recording medium to be reproduced from an appropriate player.

[0054] According to the present invention, a digital broadcasting transmitting apparatus and method thereof, a video data encoding apparatus and method thereof, and a broadcasting signal decoding system and method thereof make use of variable bit rate for a digital broadcasting system that compresses and transmits the video signal at a fixed bit rate, thereby minimizing damage to the video broadcasting quality and also securing an additional channel to provide various multimedia services there through.

[0055] The present invention uses a method of compressing data at a variable bit rate to meet a constant threshold, which has otherwise been known to be unacceptable for the digital broadcasting system that generally has fixed channel bit rates, thereby making use of the variable bit rate compression and transmission in the digital broadcasting system.

[0056] Although the preferred embodiments of the present invention have been described, it is understood that the present invention should not be limited to these preferred embodiments but various changes and modifications can be made by one skilled in the art within the spirit and scope of the present invention as hereinafter claimed, and equivalents thereof.